

AUTHORIZATION OF A TRANSACTION

5 The present invention relates in general to the field of electronic execution of transactions and more specifically to the field of authorizing a transaction by a user. In the wording of the present document, a "transaction" should be understood in particular to refer to a legal or factual procedure, the authorization of which by an authorized user must be verifiable without any doubt. Such a transaction may be, for example, an electronic payment or
10 some other financial transaction or an electronic declaration of intent.

For an electronic authorization of a transaction, it is customary to use a personal feature of the authorizing user that is known only by the user and/or can be given only with the cooperation of the user. In the past,
15 mainly secret numbers (PINs = personal identification numbers) have been used as these personal features, but the use of biometric features is becoming increasingly important. Such a biometric personal feature can be determined, for example, by scanning a fingerprint or by photographing the face or an eye of the user or by recording a sample of the user's handwriting.

20 To authorize a transaction, the user is usually instructed to enter the personal feature at a terminal and/or to make the feature accessible to the terminal. Here, however, there is the problem that the user does not in general have a reliable option for convincing himself/herself of the integrity of the terminal.
25 If the user were to make his/her personal feature accessible to a terminal set up with fraudulent intent, then the user's personal feature, such as his/her fingerprint, could be recorded and later misappropriated by the falsified terminal.

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German laid-open publication DE 41 42 964 A1 discloses a system in which a secret provided by the user – e.g., a password known only to the user – is stored in encrypted form in a chip card. Before the user is instructed to enter a PIN as a personal feature, a terminal reads out the encrypted password and
5 displays it to the user in plain text. From the display of the correct password, the user can see that this is a terminal that can be trusted because a falsified terminal could not decrypt the encrypted code word.

The system described above, however, presupposes that the user is carrying
10 a chip card or some other data carrier on which the encrypted password is stored with him/her. It would be more convenient for the user if this were not obligatorily necessary. In conjunction with biometric authorization procedures in particular, an additional requirement is often that no additional data carriers are to be used. For example, in biometric
15 authorization of a payment transaction, this is an essential point in designing the procedure to be as simple as possible.

Therefore, the object of the present invention is to avoid the aforementioned problems at least in part and to provide a technique for authorizing a
20 transaction by a user using a terminal which gives the user an opportunity to recognize a falsified terminal. In preferred embodiments, the invention should be adapted especially to the use of biometric authorization techniques.

25 According to the invention, this object is achieved entirely or in part by a method executed by a terminal according to Claim 1, a method executed by a background system according to Claim 8, a method according to Claim 13, a device according to Claim 16 and a computer program product according to

Claim 17. The dependent claims define preferred embodiments of the present invention.

The present invention is based on the basic idea of storing data about a secret
5 that is known only to the user in a background system (host system) with
which the terminal is capable of exchanging data. The background system
transmits the secret data of the user to the terminal only when the terminal
has been successfully authenticated by the background system – i.e., has
proven to be an authorized terminal. The background system usually stores
10 secret data of many users so identification of the user is necessary before the
background system can access the secret data assigned to the user.

The secret that is sent by the background system to the terminal in the form
of secret data after successful authentication of the terminal is replayed to the
15 user. The user can then be ensured that the terminal is trustworthy. To
authorize the transaction, the user can then enter his/her personal feature or
can make it accessible to the terminal without the user having to fear any
misuse. The transaction is then performed, with the personal feature of the
user serving to verify the authorization.

20 The invention offers the considerable advantage of an authentication of the
terminal that can be verified by the user without requiring the user to have a
data carrier. Acceptance of biometric authorization procedures can thereby
be increased considerably, in particular because many users have concerns
25 regarding possible misuse of their biometric data.

The order of enumeration of the steps in the method claims should not be
understood as a restriction of the scope of protection. Instead, embodiments
of the invention are provided in which these method steps are carried out in

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a different order or entirely or partially in parallel or entirely or partially interleaved. This pertains in particular to a possible interleaving of the related steps of the terminal and the background system in which data is acquired, transmitted and processed. Furthermore, in particular the
5 authentication of the terminal at the background system and the transmission of the user's identification data to the background system may take place in a single step or in multiple substeps – in any order.

For authentication of the terminal at the background system, any method
10 that would rule out the use of counterfeit terminals or would at least greatly impede such use may be employed here. As a rule, such authentication methods are based on a secret key of the terminal, and either symmetrical or asymmetrical encryption may be used. The terminal preferably transmits information to the background system for authentication, this information
15 allowing the background system to determine whether the terminal has the secret key. The secret key itself, however, should not be accessible to an unauthorized person even if the unauthorized person taps into and analyzes a large number of communication operations between the terminal and the background system.

20 In preferred embodiments, a message secured with a MAC (message authentication code) or a cryptographic signature is used for authentication of the terminal. This message preferably contains user identification data that has been input into the terminal by the user or derived by the terminal from
25 identification information pertaining to the user.

The secret that is supplied back to the user may be any type of information that is easily identified by the user and would be difficult or impossible for a counterfeit terminal to guess. Depending on the output options of the

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terminal, the information may consist of, for example, a displayed text and/or a displayed image and/or an acoustic output and/or tactile information.

- 5 To prevent the possibility of manipulation by spying on successful transactions of a user, preferred embodiments use a secret that changes from one transaction to the next and may, for example, be selected from a plurality of given secret information. In some embodiments, information regarding previous transactions, e.g., a photograph of the user at the last
10 transaction performed – may be included in the secret or may form the secret.

- In preferred embodiments, the personal feature of the user is a biometric feature. Depending on the embodiment of the terminal, for example, a
15 fingerprint of the user may be determined and/or a sample of the user's signature may be recorded and/or a photograph or scan of the user or individual body parts of the user may be prepared and/or a voice sample of the user may be analyzed. However, this is not to exclude embodiments of the invention in which the personal feature is a password or a secret number
20 or in which the personal feature is stored on a data carrier. However, such embodiments are less preferred because they are not so convenient for the user.

- The personal feature is preferably transmitted by the terminal to the
25 background system and is checked there. In the case of a successful check on the personal feature, the transaction is considered as having been authorized and the terminal may output a corresponding acknowledgement, for example. Embodiments in which the personal feature is checked entirely or partially by the terminal are not ruled out. To do so, however, it is usually

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necessary for information required for the check to be transmitted from the background system to the terminal, but this should be desirable only in exceptional cases for safety reasons.

- 5 In preferred embodiments, the communication transactions between the terminal and the background system are protected by suitable measures from spying and/or attacks by devices connected between them, especially so-called replay attacks. For example, time stamps and/or sequence numbers may be used for this purpose. In advantageous embodiments, an encryption
10 of all messages – preferably with a session key that is issued again for each session – is provided.

- The computer program product according to the invention has program instructions for implementing the method according to the invention in a
15 terminal and/or a background system. Such a computer program product may be a physical medium, e.g., a semiconductor memory or a diskette or a CD-ROM. The computer program product may also be, for example, a non-physical medium, e.g., a signal transmitted over a computer network.

- 20 The device according to the invention may be in particular a terminal or a background system or a combination of a terminal and a background system. In preferred embodiments, the device and the computer program product have features which correspond to the features mentioned in the present description and/or in the dependent method claims.

- 25 Additional features, objects and advantages of the present invention are apparent from the following description of several exemplary embodiments and alternative embodiments. Reference is made to the schematic drawings in which:

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Fig. 1 shows a system according to an exemplary embodiment of the invention in a schematic block diagram representation, and

- 5 Fig. 2A and Fig. 2B each show a section of an exemplary flow chart of a successfully authorized transaction in the system of Fig. 1.

Fig. 1 shows a background system 10 having a server 12 and a database 14. The server 12 is embodied in the form of a powerful computer which is
10 controlled by a program according to the method described below. The background system 10 serves, over a network 16, a plurality of terminals, one terminal 18 of which is shown as an example in Fig. 1. The network 16 may have multiple subsections which may be embodied, for example, as a local network and/or as a data packet network such as the Internet and/or
15 as an analog or digital telephone network.

In the present exemplary embodiment, the terminal 18 is designed as a compact independent device which has operating elements such as a keyboard or keypad 20, display elements such as a graphic display 22 and
20 elements for computing biometric features. In the present exemplary embodiment, a fingerprint sensor 24 and a camera 26 are provided for the latter purpose. In alternative embodiments, more or fewer or other biometric sensors may be provided. Furthermore, embodiments of the terminal 18 which do not have any biometric sensors but instead require input of a
25 personal feature via the keyboard 20 are also conceivable.

In the exemplary embodiment illustrated in Fig. 1, the terminal 18 is designed as an independent device which is controlled by a built-in microprocessor according to the method described below. In simple

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embodiments, transaction data – e.g., a purchase price to be paid – is entered via the keyboard 20, but it is preferable for such data to be transmitted to the terminal 18 via an electronic interface (not shown in Fig. 1). A cash register, for example, may be connected to the interface. In other alternative
5 embodiments, the terminal 18 is not an independent device but instead is incorporated, for example, into a cash register or an automatic apparatus or an access control device.

The sequence of a successfully authorized transaction illustrated in Fig. 2A
10 and Fig. 2B begins in step 30 with an identification of the user, with identification information 32 being determined. At this point in time, the user cannot yet assume that the terminal 18 is trustworthy, so as a rule non-confidential identification information 32 is used. For example, in step 30 the user may enter as identification information 32 a customer number or
15 a telephone number or his/her name – optionally together with his/her date of birth, if this is necessary for unambiguous identification – by using the keyboard 20 of the terminal 18.

In particular in the case of extensive identification information 32, the use of
20 memory cards or memory modules may be provided in some embodiments. For example, the identification information 32 may be printed as plain text or as a bar code on a card and analyzed by a reader of the terminal 18 – e.g., the cameras 26. In a similar way a magnetic card or a compact radio module (RF tag) may be used for convenient storage of the identification information 32,
25 but then of course the terminal 18 must also be equipped with a suitable reader. The methods mentioned above are not mutually exclusive. For example, if the data carrier is not at hand, the user may enter his/her name and date of birth via the keyboard 20 as a more time-consuming alternative.

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In another alternative embodiment, biometric information is used as the identification information 32. For example, a photograph of the user's face recorded by the camera 26 may be used for identification of the user.

Furthermore, a fingerprint of the user recorded by the fingerprint sensor 24
5 may also be used, for example. If the transaction is authorized on the basis of a fingerprint, the user should use a different finger for identification purposes.

In step 34 the terminal 18 calculates data 36 that is transmitted to the
10 background system 10. This data 34 contains in encrypted form user identification data ID and a first time stamp TS1. The encryption is indicated by the designation "ENC(...)" in Fig. 1; the symbol "||" stands for joining two respective components of a message.

15 The user identification data ID is identical in some embodiments to the identification information 32 determined by the terminal 18 in step 30. This may be the case in particular if the identification information 32 is in compact form. However, if very extensive identification information 32 is obtained by the terminal 18, e.g., in the case of biometric data acquisition,
20 preprocessing in the terminal 18 may be advantageous to derive suitable feature values to be used as the user identification data ID from the identification information 32.

The data transmitted to the background system 10 in step 34 is also protected
25 by a data securing code, which is referred to below as MAC (message authentication code). Conceptually a MAC is a hash value or "fingerprint" into which is input first the message to be transmitted – in this case the encrypted user identification data ID and the first time stamp TS1 – and also a secret key of the terminal 18. Methods of calculating a MAC are known and

are described for example in chapter 9.5 of the book "*Handbook of Applied Cryptography*" by A. Menezes et al., CRC Press, 1996, pages 352-359.

5 In step 38 the background system 10 performs an authentication of the terminal 18. In the present exemplary embodiment, the background system 10 knows the secret key of the terminal 18 and can therefore check the MAC calculated by the terminal 18. In alternative embodiments, instead of a MAC based on a symmetrical encryption method, a cryptographic signature based on an asymmetrical method may be used. To analyze such a cryptographic
10 signature, only a public key of the terminal 18 need be known to the background system 10. Furthermore, embodiments in which a session key is negotiated between the terminal 18 and the background system 10 and a secure encrypted communications channel is established are also conceivable.

15 If the authorization of the terminal 18 in step 38 fails, the method is terminated. Otherwise the background system 10 performs a search query in the database 14 in step 40 to access secret data SEC assigned to the user. There may be a search for an entry in the database 14 containing the user
20 identification data ID in identical form or merely a similarity comparison may be performed. The latter is provided in particular when the user identification data ID is derived from biometric identification information 32.

Each entry assigned to a user in the database 14 contains secret data SEC on
25 at least one secret of a user. In the present exemplary embodiment, a single static secret is used. Alternative embodiments with several secrets and/or dynamic secrets are described below.

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In step 42, the secret data SEC determined from the database 14 is provided with a second time stamp TS2, encrypted and secured with another MAC. The data 44 thus obtained is transmitted to the terminal 18.

- 5 In step 46 (Fig. 2B) the terminal 18 first performs an authentication of the background system 10 on the basis of the MAC contained in the data 44. This authentication is less critical than the authentication in step 38 because a counterfeit background system 10 would not have any knowledge of the secret expected by the user. Furthermore, in step 46 the terminal 18 evaluates
- 10 the second time stamp TS2 and checks on whether the time indicated there is later than the time of the first time stamp TS1. Some embodiments may also provide a check on whether or not a maximum allowed time difference has been exceeded between the two time stamps TS1 and TS2.
- 15 The check of the time stamp serves to protect against an attack in which a previous communication operation is recorded and played back (so-called replay attack). In alternative embodiments, instead of or in addition to the time stamps, random numbers may also be used to match requests and the corresponding responses and/or a send sequence counter may be used.
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- In step 48, the secret data SEC contained in encrypted form in the data 44 is decrypted and played back to the user as a secret 50. The secret 50 may be any type of information suitable for proving to the user that there has been successful authentication of the terminal 18 at the background system 10 in
- 25 step 38. For example, as the secret 50, the user may be shown an image selected by the user or a password selected by the user and appearing on the display 22 of the terminal 18. In addition to or instead of the visual playback of the secret 50, an acoustic and/or tactile playback is also possible.

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Before or after or simultaneously with the playback of the secret 50 in step 48, the transaction data 54 mentioned above, which may indicate the purchase price to be paid, for example, is displayed to the user in step 52. Display of the correct secret 50 signals to the user that the terminal 18 can be trusted because the background system 10 would transmit the secret 50 to the terminal 18 only after successful authentication of the terminal 18. Therefore, the user need not have any concerns about making accessible to the terminal 18 a personal feature 56 that has been established in advance.

- 5 The personal feature 56 may be, for example, a fingerprint which is input by the terminal 18 in step 58 when the user places his/her finger on the fingerprint sensor 24. In alternative embodiments, other biometric features, e.g., a password spoken by the user or the iris of the user recorded by the camera 26, may be used as the personal feature 56. Furthermore a biometric feature may be combined with a password input or code number input via the keyboard 20, or in some embodiments only a keyboard/keypad input may be provided or a keyboard/keypad input may be provided as an optional alternative to the biometric test.
- 10 The process whereby the user inputs the personal feature 56 into the terminal 18 or makes this feature accessible to the terminal 18 represents a declaration of intent with which the user authorizes the transaction. The user thereby states his/her consent, e.g., with the payment of the purchase price indicated in step 52.

- 15 The terminal 18 then converts the personal feature 56 determined in step 58 into feature data FEAT which is a compact representation of the personal feature 56. Such a conversion is desirable in particular for volume reduction

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of biometric data. In some alternative embodiments, the feature data FEAT and the personal feature 56 may also be identical.

The feature data FEAT is encrypted together with the transaction data 54 (labeled as "TD" in Fig. 2B) and a third time stamp TS3 and transmitted along with another MAC as data 62 to the background system 10. In step 64, the background system 10 checks the MAC and decrypts the data 62. Furthermore in step 64 the background system 10 performs a time stamp check to be sure that the third time stamp TS3 indicates a later point in time than the second time stamp TS2. If the check in step 64 has been successful, then in step 66 the background system 10 will perform a check of the feature data FEAT. In doing so, the background system 10 will access data contained in the database 14 in the entry assigned to the user.

15 Since the personal feature 56 in the exemplary embodiment described here is a biometric feature, in step 66 a corresponding biometric test method that has in particular a high reliability against false positive results must be performed. Such methods are known in many embodiments and as such are not the object of the present invention.

20 In case of a successful check of the personal feature 56 and/or the feature data FEAT in step 66, the transaction is executed in step 68. Depending on the type of transaction, for example, the background system 10 may relay data regarding the desired payment to an affiliated financial institution or may store such data in the data record assigned to the user in the database 14. If the check of the feature data FEAT in step 66 has yielded a negative result, the transaction is not performed and the method is terminated. The same thing of course also applies if one of the previous test steps 46 and 64 has failed.

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Then in step 70, the background system 10 creates acknowledgement data CD regarding the successful transaction. This acknowledgement data CD is provided with a fourth time stamp TS4, encrypted and again secured with a
5 MAC. The resulting data 72 is transmitted to the terminal 18 where in step 74 additional test steps pertaining to the MAC and the fourth time stamp TS4 are performed. If this check fails, a corresponding warning may be output to the user and/or the background system 10.

10 In the case of a successful check in step 74, the terminal 18 outputs the decrypted acknowledgement data CD as an acknowledgement 78 in step 76. The acknowledgement 78 may be displayed on the display 22, for example, or printed out by means of a printer (not shown in Fig. 1). The method is thus concluded.

15 With the exemplary embodiment described so far, a single static secret is provided for each user. However, alternative embodiments are possible in which several versions of secret data SEC corresponding to different codings of the secret 50 for differently equipped terminals 18 are stored in the
20 database 14. In these embodiments, the terminal 18 transmits in step 34 additional information about the available playback options to the background system 10, and in step 42 the background system 10 makes available suitable secret data SEC.

25 As an alternative or in addition to different versions of a secret, the database 14 may also have secret data SEC for several different secrets for each user in some embodiments. The choice of one of these secrets in step 40 may then be made, e.g., randomly or according to a given sequence so that in step 48 a secret 50 that changes from one transaction to the next is displayed to the

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user. For such a dynamic secret, replay attacks based on replaying previous transactions are made considerably more difficult.

As an alternative or in addition to the aforementioned possibility of creating
5 a dynamic secret, it is also possible to provide for the background system 10
to generate secret data SEC for a dynamic secret in step 40 depending on
previous transactions. In particular, the dynamic secret may consist entirely
or partially of information about the last transaction performed. Thus for
example the date and/or amount of the last purchase and/or a photograph
10 of the customer recorded by the camera 26 at the last transaction may serve
as a dynamic secret. In these embodiments, the required data must of course
also be stored in database 14.

It is self-evident that the details contained in the above description of
15 exemplary embodiments should not be interpreted as restrictions of the
scope of the present invention. Many modifications and other alternative
embodiments are possible and are self-evident for those skilled in the art.